Changes in Causes of Maternal Mortality in Zimbabwe 2007-08 to 2018-19: Findings From Two Reproductive Age Mortality Surveys

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Abstract

Background: Reducing maternal mortality is a priority of Sustainable Development Goal (SDG) 3.1 which requires frequent epidemiological analysis of trends, patterns and causes of maternal deaths. We conducted two reproductive age mortality surveys (RAMOS) to analyse the epidemiology of maternal mortality in Zimbabwe; assessing changes in the causes of death between 2007-08 and 2018-19.

Methods: We collected data for deaths among women of reproductive ages (WRAs), and pregnancy-related deaths (PRDs) in 11 districts using multi-stage cluster and simple random sampling. We calculated mortality incidence rates (IR) and incidence rate ratios (IRR) per 10000 WRA with 95% confidence intervals (CIs) in ICD-10 groups. We calculated IR and IRR (per 10000 births) for PRDs with 95% CIs in ICD-MM groups. We also calculated maternal mortality ratios (MMR), per 100 000 live births, for selected causes of PRDs.

Results: We identified 6188 deaths among WRAs and 325 PRDs in 2007-08, and 1856 and 137 respectively in 2018-19. Mortality in WRAs decreased by 81% in certain infectious or parasitic diseases, by 82% in diseases of the respiratory system, and by 79% in diseases of the digestive system. Pregnancy-related deaths from direct causes decreased by 61% and deaths from indirect causes by 84%. HIV/AIDS-related deaths decreased by 81% in WRAs and by 91% in pregnant women. However, direct causes of death still had a three-fold MMR (151 deaths) than indirect causes (51 deaths per 100 000), and obstetric haemorrhage alone had equal MMR as all indirect causes in 2018-19.

Conclusion: HIV-related mortality has declined significantly in Zimbabwe in WRAs and pregnant women, though it is still an important cause of death. Zimbabwe has also reduced pregnancy-related deaths from direct causes significantly, through multipronged interventions. The focus is to improve coverage and quality of antenatal care to reduce deaths from indirect causes, and increase access to emergency obstetric care to further reduce deaths from the direct causes.

Introduction

Reducing maternal mortality is a priority of Sustainable Development Goal (SDG) 3.1 and the target is to reduce the global maternal mortality ratio (MMR) to 70 maternal deaths per 100 000 live births by 2030, and to leave no country with an MMR greater than double the global average.[1] These targets require systematic epidemiologic analysis of levels, trends and causes of maternal deaths to periodically assess progress towards this goal.[2,3,4] Analysis of the MMR evaluates efforts to reduce the levels, while analysis of the causes of death identifies the aetiologies to target with ongoing interventions to reduce maternal mortality.

The World Health Organisation (WHO) developed the international classification of diseases (ICD), which groups diseases and causes of death into standard categories to aid their analysis. Currently, the 10th Edition of the ICD (ICD-10) is used to classify diseases and causes of death in the general population, including women of reproductive ages (WRAs).[5] The 1st edition of the manual for classifying deaths

during pregnancy, childbirth and the puerperium (ICD-MM) is currently used to classify pregnancy-related deaths.[6,7] The ICD manuals enable standardised coding and description of diseases and causes of death globally.

Several studies have suggested a decline in Zimbabwe's maternal mortality ratio (MMR) during the last decades. The Zimbabwe Demographic and Health Survey (ZDHS) suggested a decline from 960 in 2011 to 651 in 2015,[8,9] the Multiple Indicator Cluster Survey (MICS) suggested a decline from 614 in 2014 to 462 in 2019,[10,11] and the United Nations Maternal Mortality Estimation Inter-agency Group (MMEIG) estimated a decline from 790 in 2008 to 458 in 2017.[12] Despite the reductions alluded, these estimates suggest that Zimbabwe's MMR remains unacceptably high, raising the need for studies to identify the causes of maternal deaths, which should be prioritised in ongoing interventions.

We conducted two reproductive age mortality surveys (RAMOS) to analyse the epidemiology of maternal mortality in Zimbabwe by assessing changes in the MMR and causes of death between 2007-08 and 2018-19. The study protocol has been published elsewhere.[13] Another paper will report changes in the MMR. This paper describes the important changes that occurred in the causes of reproductive age and maternal mortality in Zimbabwe during the review period.

Methods

Study design

We conducted two cross-sectional RAMOS using multi-stage cluster sampling. The surveys collected data for births and deaths among WRAs, and maternal deaths, in 11 districts. We designed the surveys to produce representative samples of births needed to calculate the MMR and stratified the population by province (n=10), selecting one district from each province using simple random sampling. An additional district was selected in Harare, the capital province. The sample sizes for the surveys were 45000 and 46000 births respectively. The study protocol describes in detail the sampling procedures and sample size calculations.[13]

Study setting

The 11 study districts (provinces) were: Mutare (Manicaland), Mutoko (Mashonaland East), Bindura (Mashonaland Central), Zvimba (Mashonaland West), Chivi (Masvingo), Kwekwe (Midlands), Tsholotsho (Matabeleland North), Matobo (Matabeleland South), Nkulumane (Bulawayo), and South-Eastern and Western (Harare). Mutare, Bindura and Kwekwe are partly urban districts. Nkulumane, Harare South and Eastern, and Harare Western are urban districts (See Figure 1).

Data collected

We collected data for deaths among WRAs on location (province, district and place of residence – rural/urban), age (completed years), pregnancy status (pregnant or not), and causes of death (as stated

on medical and death certificates). For pregnancy-related deaths we collected data on complications suffered and birth outcomes, institutions where patient was referred to (level of facility – district, provincial or tertiary hospital, and reasons for referral), causes of death (as above) and place of death (home or institutional).

Data collection procedures

The data were collected from civil registration and vital statistics (CRVS) records at the government's Registrar General's (RG's) offices and health facility records. The health records included patient registers and charts at the following sites: maternity units, theatres, high dependency and intensive care units, gynaecological, medical and surgical wards, mortuaries, hospital police posts, and casualty departments. In addition, village health workers and village heads recorded home deaths in community registers in 2007-08, and trained research nurse-midwives interviewed the deceased women's close relative present at the time of death (husband, mother, sister or other) using verbal autopsy forms adapted from the WHO.[14] In 2018-19, additional deaths were identified in maternal death notification forms from the Ministry of Health and Child Care's district, provincial and national reproductive health offices.

Civil registration and vital statistics (CRVS) policy and procedures

The CRVS and health system data are regulated by government legislation in Zimbabwe. The law enforces registration and issuance of certificates for all deaths,[15] and requires health institutions and relatives or village heads of persons who die at home to notify the death at the RG's office to create a death record and issue a death certificate. Medical officers or nurses who attend a death in a health institution complete and sign a medical death certificate. Family members report home deaths to the police, which takes the bodies to hospitals, where medical officers perform post-mortems and issue medical death certificates with causes of death. Health institutions submit the medical death certificates to RG's district offices, where death records are created. The RG's officers file the death records by year and date and store them in secure record rooms.

Data collection period

We conducted data collection for the first survey prospectively between 1st May 2007 and 15th June 2008 and repeated it between 1st May and 31st July 2020. We collected data for the second survey, covering the period 1 May 2018 to 15 June 2019, between 1st May and 31st July 2020 and repeated it between 3rd May and 20th July 2021.

Definitions

WRAs were women aged 15 to 49 years. Pregnancy-related deaths were deaths during pregnancy or within 42-days of termination of pregnancy or delivery, irrespective of the cause of the termination of pregnancy and death.[12] Maternal deaths were deaths of women during pregnancy or within 42-days of termination of pregnancy or delivery, irrespective of the duration and site of the pregnancy, from any

cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes.[6,12]

Eligibility criteria and participant selection

Deaths among WRAs resident in the study districts who died from any cause, in health institutions or home, with their death records filed in the district RG's office were eligible for study, including those who died in referral hospitals in other districts. Similarly, pregnancy-related deaths of district residents, which occurred in the local or referral hospitals, at home or in transit, were eligible for study.

Data analysis

We calculated mortality incidence rates (IR) and incidence rate ratios (IRR) (per 10 000 WRA) with 95% confidence intervals (CIs) in ICD-10 groups, and IR and IRR (per 10 000 deliveries) with 95% CIs for pregnancy-related deaths in ICD-MM groups and specific causes. We calculated cause-specific MMRs with 95% CIs for the leading causes of pregnancy-related deaths. We also calculated percentages of maternal deaths in ICD-MM groups (out of total maternal deaths), ranked the causes (by the percentage of deaths), identified and compared the leading causes of maternal deaths in Zimbabwe, Southern Africa (SA) and Sub-Saharan Africa (SSA). Cause-of-death data for SA and SSA came from a recent systematic review.[16]

Results

Deaths among women of reproductive ages (WRAs)

We identified 6 188 WRAs in 2007-08 and 1 856 in 2018-19 (Table 1). All except eight deaths of WRAs were in 12 cause groups. The ICD-10 group “certain infectious or parasitic diseases” constituted 60% of all deaths in 2007-8 and 44% in 2018-19, where HIV/AIDS constituted 96% of deaths in this group and was the leading cause of death in both study periods; causing 58% (3568/6188) of deaths in 2007-08 and 43% (790/1856) of deaths in 2018-19.

Mortality declined significantly in six groups: certain infectious or parasitic diseases (81%), diseases of the respiratory system (82%), diseases of the nervous system (70%), diseases of the circulatory system (69%), diseases of the digestive system (79%) and pregnancy and childbirth (64%).

Table 1
Causes of death among women of reproductive age (15-49 years) in Zimbabwe, 2007-2008 and 2018-2019

Cause of death (ICD-11 group)	2007-2008		2018-2019		IRR (95% CI)
	Number of deaths	IR/10000	Number of deaths	IR/10000	
Certain infectious or parasitic diseases*	3728	62.0	823	11.7	0.19 (0.18-0.21)
HIV/AIDS*	3568	59.4	790	11.2	0.19 (0.17-0.20)
Malaria*	159	2.6	32	0.45	0.17 (0.11-0.25)
Neoplasms	100	1.7	106	1.5	0.90 (0.68-1.2)
Diseases of the blood or blood-forming organisms	39	0.65	27	0.38	0.59 (0.35-1.0)
Endocrine, nutritional, or metabolic diseases	38	0.63	32	0.45	0.72 (0.43-1.2)
Diseases of the nervous system	296	4.9	103	1.5	0.30 (0.23-0.37)
Diseases of the circulatory system	252	4.2	122	1.7	0.41 (0.33-0.51)
Diseases of the respiratory system	480	8.0	103	1.4	0.18 (0.15-0.23)
Diseases of the digestive system	599	10.0	148	2.1	0.21 (0.17-0.25)
Diseases of the musculoskeletal system and connective tissue	25	0.42	8	0.11	0.27 (0.11-0.62)
Diseases of the genitourinary system	23	0.38	36	0.51	1.3 (0.77-2.4)

Cause of death (ICD-11 group)	2007-2008		2018-2019		IRR (95% CI)
	Number of deaths	IR/10000	Number of deaths	IR/10000	
Pregnancy, childbirth, and the puerperium	325	5.4	137	1.9	0.36 (0.29-0.44)
Injury, poisoning, and certain other consequences of external causes	118	2.0	109	1.5	0.79 (0.60-1.0)
Other groups**	8	-	4	-	-
Insufficient information	240	-	177	-	-
Unknown	21	-	20	-	-
Total deaths	6188	103.1	1856	26.4	0.26 (0.24-0.27)
Population	600344	-	704176	-	-

* The group includes cases that are in group 18 but were due to infections in group 1.

** For 2007: Diseases of the immune system – 1; mental, behavioural or neurodevelopment –2; diseases of the skin –3, conditions related to sexual health –1, developmental anomalies –1; For 2018: Diseases of the immune system –1; diseases of the ear or mastoid process –1; diseases of the skin –8.

Pregnancy-related deaths

We identified 325 pregnancy-related deaths in 2007-08 and 137 in 2018-19 (Table 2). Direct causes accounted for 55% (180/325) of the deaths in 2007-08 and 75% (103/137) in 2018-19. Deaths due to direct causes decreased by 61%. Within this category, deaths more than halved in three groups– hypertensive disease in pregnancy (50%), obstetric haemorrhage (64%), pregnancy-related infections (86%), and the largest decline occurred in puerperal sepsis (91%).

Table 2
Causes of pregnancy-related deaths in Zimbabwe, 2007-08 and 2018-19; Incidence rate (IR) and Incidence rate ratio (IRR) per 10 000 and 95% confidence intervals (CI)

Cause of death (ICD10-MM Group and specific causes)*	**2007-2008**		**2018-2019**		**IRR (95% CI)**
	Number of deaths	**IR/10000**	**Number of deaths**	**IR/10000**	
Direct causes	**180 (55%)**	**39.5**	**103 (75%)**	**15.3**	**0.39 (0.30-0.50)**
1 Pregnancies with abortive outcome	**30**	**6.6**	**24**	**3.6**	**0.54 (0.30-0.96)**
Unsafe/septic /complications of abortion	19	4.2	12	1.8	0.43 (0.19-0.93)
Ectopic pregnancy/ruptured ectopic pregnancy	7	1.5	7	1.0	0.68 (0.20-2.3)
Peri-abortal haemorrhage	4	0.88	5	0.74	0.85 (0.18-4.3)
2 Hypertensive disorders in pregnancy	**34**	**7.5**	**25**	**3.7**	**0.50 (0.29-0.86)**
Severe/Pre-eclampsia/Eclampsia	34	7.5	22	3.3	0.44 (0.24-0.77)
Hypertensive disease in pregnancy	0	0.0	3	0.44	-
3 Obstetric haemorrhage	**64**	**14.0**	**34**	**5.1**	**0.36 (0.23-0.55)**
Unspecified obstetric haemorrhage	26	5.7	17	2.5	0.44 (0.23-0.85)
Postpartum haemorrhage/PPH	26	5.7	11	1.6	0.29 (0.13-0.60)
Antepartum haemorrhage/APH	4	0.88	2	0.30	0.34 (0.03-2.4)

Cause of death (ICD10-MM Group and specific causes)*	2007-2008		2018-2019		IRR (95% CI)
	Number of deaths	IR/10000	Number of deaths	IR/10000	
Ruptured uterus/Uterine rupture	8	1.8	4	0.60	0.34 (0.07-1.27)
4 Pregnancy-related infections	**33**	**7.2**	**7**	**1.0**	**0.14 (0.05-0.33)**
Puerperal sepsis	32	7.0	4	0.60	0.08 (0.02-0.24)
Chorioamnionitis/Septicaemia	1	0.22	3	0.45	2.0 (0.16-106.8)
5 Other obstetric complications	**14**	**3.1**	**12**	**1.8**	**0.58 (0.25-1.4)**
Obstructed/prolonged labour	7	1.5	1	0.14	0.10 (0.0-0.75)
Obstetric/pulmonary embolism	3	0.66	2	0.30	0.45 (0.04-3.9)
Cardiomyopathy/Postpartum cardiomyopathy	3	0.66	8	1.2	1.8 (0.43-10.6)
Hyperemesis gravidarum	1	0.22	1	0.14	0.68 (0.01-53)
6 Unanticipated complications of management	**5**	**1.1**	**1**	**0.14**	**0.14 (0.0-1.2)**
Anaesthetic complications/High spinal anaesthesia	5	1.1	0	0.0	0.0 (0.0-0.74)
High spinal	0	0.0	1	0.14	-
Indirect causes	**145 (45%)**	**31.8**	**34 (26%)**	**5.2**	**0.16 (0.11-0.24)**

Cause of death (ICD10-MM Group and specific causes)*	2007-2008		2018-2019		IRR (95% CI)
	Number of deaths	IR/10000	Number of deaths	IR/10000	
7 Non-obstetric complications	**113**	**22.6**	**29**	**4.2**	**0.18 (0.12-0.28)**
HIV/AIDS	72	15.8	10	1.5	0.09 (0.04-0.18)
Malaria	23	5.0	2	0.30	0.06 (0.01-0.24)
Tuberculosis	8	1.8	2	0.30	0.17 (0.02-0.85)
Cardiac disease	5	1.1	3	0.45	0.41 (0.06-2.1)
Other indirect causes	5	1.1	12	1.8	1.6 (0.53-5.9)
8 Unknown/undetermined causes	**19**	**4.2**	**3**	**0.45**	**0.11 (0.02-0.36)**
Unknown/unspecified causes	19	4.2	3	0.45	0.11 (0.02-0.36)
9 Coincidental causes	**13**	**2.9**	**2**	**0.30**	**0.10 (0.01-0.46)**
Assault, Poisoning, Suicide, RTA	13	2.9	2	0.30	0.10 (0.01-0.46)
Total deaths	325	71.3	137	20.4	0.29 (0.23-0.35)
Total deliveries	45579	-	67225	-	-

Deaths due to indirect causes decreased by 84%, with deaths due to non-obstetric complications decreasing by 82%. The largest declines occurred in HIV/AIDS (91%), and malaria (94%). HIV/AIDS dropped from being the top cause of death in 2007-08 (16 deaths) to fourth cause (2 deaths) in 2018-19,

behind the direct causes of eclampsia (3 deaths), abortion-related complications (4 deaths) and postpartum haemorrhage (3 deaths per 10 000).
Direct causes of death had a three-fold MMR (151 maternal deaths per 100 000) than indirect causes (51 maternal deaths per 100 000) in 2018-19. Obstetric haemorrhage alone had the same MMR as all indirect causes of death (Table 3).

Table 3
Cause-specific maternal mortality ratio (MMR) for selected cause of death groups in Zimbabwe, 2018-19

Cause of death group	Maternal deaths	MMR[1] (95% CI)
Direct causes	**103**	**153 (125 – 186)**
Obstetric haemorrhage	34	51 (35 – 71)
Pregnancies with abortive outcome	24	38 (23 – 53)
Hypertensive disorders in pregnancy	25	37 (24 – 55)
Other obstetric complications	12	18 (9 – 31)
Pregnancy-related infections	7	10 (4 – 21)
Indirect causes	**34**	**51 (35 – 71)**
Non-obstetric complications	29	43 (29 – 62)
HIV/AIDS	10	15 (7 – 27)

[1] MMR = (number of maternal deaths ÷ number of live births) x 100 000. The number of live births was 67225 in 2018-19.

Table 4
Comparison of pregnancy-related deaths in ICD-MM groups in Zimbabwe, Southern and Sub-Saharan Africa, 2018-2019

ICD-MM group and cause of death	Zimbabwe, 2018-2019		Southern Africa (SA), 2018-2019		Sub-Saharan Africa (SSA), 2018-2019	
	Percentage (95% CI)	Rank	Percentage (95% CI)	Rank	Percentage (95% CI)	Rank
O1: Pregnancies with abortive outcome	18% (12%-26%)	3.5	7.5% (6.7%-8.4%)	6	7.2% (5.3%-9.1%)	5
O2: Hypertensive disorders in pregnancy	18% (12%-26%)	3.5	18% (17%-19%)	3	22% (20%-24%)	2
O3: Obstetric haemorrhage	25% (18%-33%)	1	25% (24%-27%)	1	29% (27%-31%)	1
O4: Pregnancy-related infections	4.4% (1.6%-9.3%)	6	8.8% (8%-10%)	5	12% (10%-13%)	4
O5: Other obstetric complications	7.3% (3.6%-13%)	5	3.6% (3.1%-4.3%)	7	5.0% (3.1%-7.0%)	6
O6: Unanticipated complications of management	0.7% (0.0%-4.0%)	9	10% (10%-11%)	4	4.0% (1.6%-6.3%)	7
O7: Non-obstetric complications	21% (15%-29%)	2	23% (22%-24%)	2	19% (16%-21%)	3
O8: Unknown/undetermined causes	2.1% (0.5%-6.3%)	7	3.5% (2.9%-4.1%)	8	2.5% (0.0%-4.9%)	8
O9: Coincidental causes	1.0% (0.0%-5.0%)	8	0.0%	9	0.0%	9
Total deaths	137		3736		11 431	

Discussion

Analysing the causes of pregnancy-related and reproductive age mortality together provides important insights into the reasons for the decline. Sometimes declines in pregnancy-related mortality are associated with declines in WRAs because the interventions for non-obstetric diseases and causes of death in the general population also benefits pregnant women.[2–4]

Our study found significant declines in deaths due to different causes in WRAs and pregnant women in Zimbabwe from 2007-08 to 2018-19. Mortality among WRAs significantly declined in six out of twelve ICD-10 groups; mainly among groups associated with HIV/AIDS, such as certain infectious and parasitic diseases, respiratory system, and digestive system diseases. HIV and malaria are the main infectious and

parasitic diseases in Zimbabwe.[5] Respiratory diseases such as pulmonary tuberculosis and bacterial pneumonia and digestive system diseases such as acute gastroenteritis are AIDS-related in high HIV burden countries.[17,18] Zimbabwe has achieved significant reductions in HIV-related [19–21] and malaria deaths.[22] Improvement in the provision of antiretroviral therapy (ART) has reduced HIV-related mortality significantly. ART began in 2004,[23] and was rolled out to 91% (1,566/1,722) health facilities by December 2017. [24] By 2019, 97% of adults (15-49 years) with known HIV-positive status were on ART.[25] On the contrary, mortality due to non-infectious diseases was stable among WRAs, consistent with observed trends of non-communicable diseases (NCDs) in Africa.[26,27]

Among pregnant women, deaths due to direct causes decreased by two-thirds (61%). Their decline resulted from several interventions implemented by the government and its partners. A maternal and neonatal health roadmap was developed to guide the prioritized interventions.[28] Nation-wide trainings were conducted for medical officers and nurses on basic and comprehensive emergency obstetric and newborn care (BEmONC and CEmONC).[29,30] BEmONC was rolled-out in primary care and CEmONC in secondary and tertiary facilities.[29,31,32] Guidelines for maternal and perinatal death surveillance and response (MPDSR) were developed, [33] and maternal and perinatal death audits instituted in the health system.[31] Maternity waiting homes were expanded, which allowed women to stay at delivery facilities from the third trimester until delivery, to increase access to ANC and reduce home births.[34–37] Government removed user fees for maternity care through support from the health transition fund (HTF) (2012-2015) and health development fund (HDF) (2016-2020).[38–41] Access to maternity care and institutional deliveries increased, as the ZDHS reported an increase from 65% in 2007-11 to 72% in 2012-16,[8,9] while MICS reported 86% in 2015-19.[10] Caesarean section deliveries also increased.[42–44]

Pregnancy-related deaths from indirect causes decreased by more than four-fifths (84%), of which HIV/AIDS was the leading cause in 2007-08, before the widespread availability of antiretroviral therapy (ART).[23] A that time, significant proportions of pregnant women went through their antenatal period not knowing their HIV status.[20,21] By 2018-19, the situation had changed significantly. Comprehensive HIV testing and treatment services were widely available antenatally.[45–48] The "Option A" PMTCT regimen was introduced in 2011, initiating pregnant and breastfeeding women with a CD4 count of 350 cells/µl of blood or less on ART. Zimbabwe moved to "Option B+" in 2013, initiating all HIV-positive pregnant and breastfeeding women on life-long ART.[45,25] Thus, over 50% of HIV-positive pregnant women attended their first ANC visit already on ART in 2018.[49] HIV/AIDS dropped to the fourth cause of death, after the direct causes of abortion, eclampsia, and postpartum haemorrhage.

The top three causes of maternal deaths in 2018-19 (obstetric haemorrhage, hypertensive disorders in pregnancy and non-obstetric causes) were the same as in SA and SSA (Table 4).[16] Abortion-related deaths were higher in Zimbabwe than SA and SSA (18% vs. 7%), despite the known challenges of identifying them because of prohibitive legislation and religious objections.[50–52] Unanticipated

complications of management deaths were possibly poorly reported because medical staff fear blame and litigation.[53,54]

Zimbabwe halved deaths due to direct causes of maternal deaths (hypertension, haemorrhage, pregnancy-related infections) and the indirect causes of HIV/AIDS and malaria. Interventions implemented at various levels of the health system: policy development (roadmap), training (EmONC), providing access (maternity waiting homes, removal of user fees), monitoring and evaluation (MPDSR) achieved this impact. The achievements demonstrated how concerted multipronged interventions can reduce maternal mortality.

Notwithstanding, direct causes continued to cause maternal deaths than indirect, with a three-fold cause-specific MMR. Addressing obstetric haemorrhage would reduce deaths from direct causes by a third, while addressing obstetric haemorrhage, abortion and hypertensive disease would reduce direct-cause deaths by four-fifths. Thus, improving the coverage and quality of maternity care remains a priority. Efforts to reduce unskilled deliveries at home and ill-equipped primary-care facilities, improve emergency transport and increase access to the right care should continue.[55–59] Hypertensive diseases in pregnancy must also be kept in check as NCDs increase in SSA.[26,27,60,61]

Strengths and weaknesses

Our study has several strengths. The two surveys used the same design and data sources and had comparable results. The study used ICD-10 and ICD-MM to classify and code the causes of death; hence the findings are comparable with regional trends. The use of verbal autopsy forms and triangulation of data sources (civil records, patient records, death notification forms) improved the identification of the causes of death. Classification of the deaths by trained obstetricians using the ICD-10 and ICD-MM manuals minimized misclassifications of the causes.

The limitation of our study is the possible under-representation of community deaths in 2018-19 data. The 2007-08 survey collected home deaths in the community, while the 2018-19 survey only included community deaths recorded in the health system and CRVS. Some of the deaths identified in CRVS without health records had insufficient cause-of-death information. Despite these limitations, the study identified sufficient deaths that were thoroughly reviewed by obstetricians to produce these findings.

Conclusion

Mortality due to HIV and malaria has declined significantly in Zimbabwe in WRAs and pregnant women, though the two remain important causes of death. Zimbabwe has also significantly reduced pregnancy-related deaths from direct causes (pregnancy-related infections, obstetric haemorrhage and hypertensive disease in pregnancy) through concerted multipronged interventions. Sustained investment into the health system focusing on improving coverage and quality of antenatal care and access to emergency obstetric care will further reduce deaths from direct causes (haemorrhage, eclampsia and abortion).

Efforts to contain the indirect causes of HIV and malaria should continue whilst increasing efforts to manage NCDs in pregnancy. The RAMOS should be repeated in the same districts before 2030, to assess progress towards the SDG target.

Abbreviations

ART: Antiretroviral therapy; BD: Birth and death; CI: Confidence interval, CRVS: Civil registration and vital statistics; DHS: Demographic and health survey; DHIS: District health information system; ICD: International classification of diseases; MDSR: Maternal death surveillance and response; MDG: Millennium development goal; MICS: Multiple indicator cluster survey; MMR: Maternal mortality ratio; PRD: Pregnancy-related death; RAMOS: Reproductive age mortality study; RG: Registrar general; SSA: Sub-Saharan Africa; SDG: Sustainable development goal; TFR: Total fertility rate; VA: Verbal autopsy; WRA: Women of reproductive age.

Declarations

Ethics approvals and consent to participate

The study protocol received ethical approvals from the Research Ethics Committee of the Faculty of Science of the University of Pretoria (339/2019), WHO Research Ethics Committee (ERC 0003348), Human Reproduction Program Ethics Review (2019-03-19), and Medical Research Council of Zimbabwe (MRCZ/A/2613). All ethics approvals waived informed consent to participate because the study used secondary data. This study was conducted in accordance with the Declarations of Helsinki.

Consent for publication

Not applicable

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Authors' contributions

SPM developed and implemented the protocol for the 2007-08 survey with the first Zimbabwe Maternal and Perinatal Mortality Study (ZMPMS) group. RM[1] developed the 2018-19 survey and combined

analysis protocol, and implemented it with the 2018-19 ZMPMS group (See additional file 1). RM[1] conceptualised and developed the manuscript. GM, SPM and others classified the deaths using ICD-11 and ICD-MM. LN, SN, RP and SPM critically reviewed the data and draft manuscripts. All authors reviewed and approved the final manuscript.

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Availability of data and materials

The dataset supporting the conclusions of this article will be available to the public via this link: https://drive.google.com/drive/folders/1hOH_V9AjVXG6Sefdhe7QWOOnZacuM-sL

Conflicts of interest

All authors have no conflicts of interest to declare.

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Figures

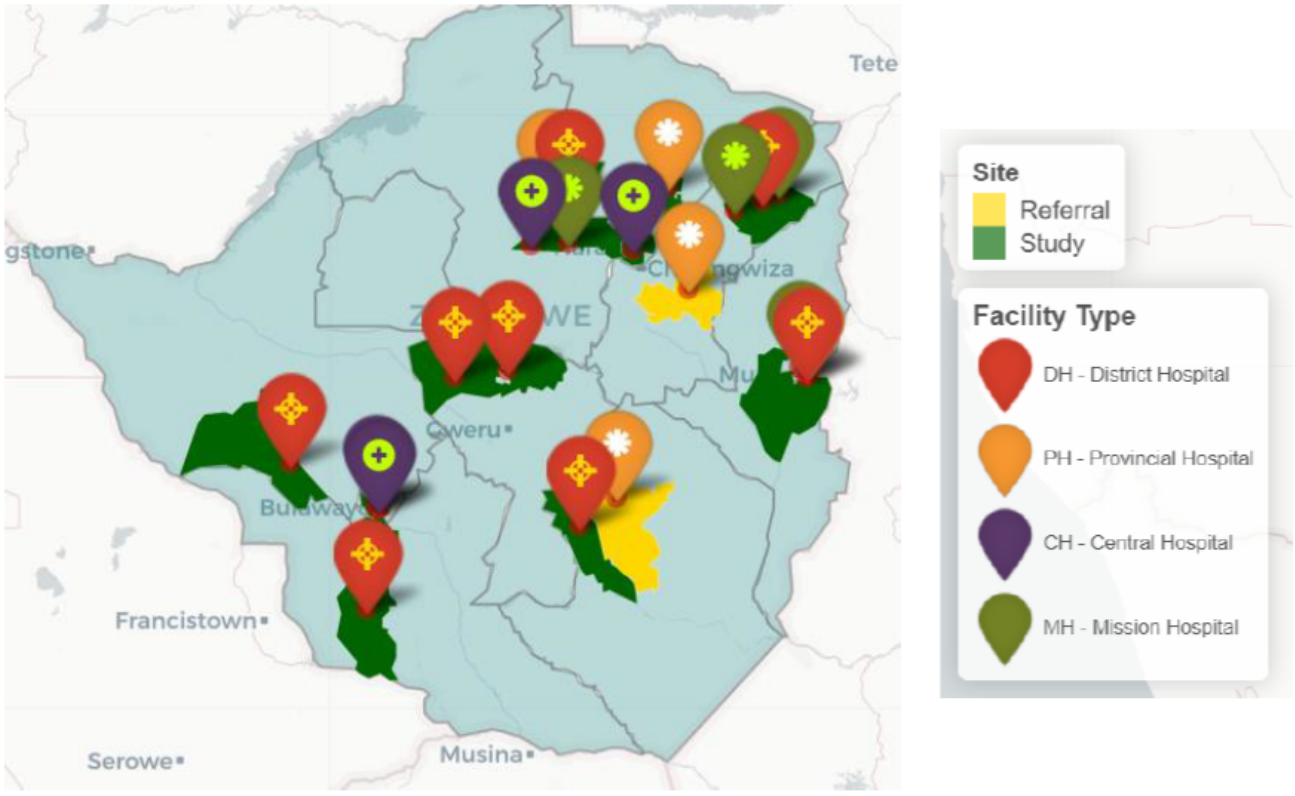

Figure 1

Map of Zimbabwe Maternal and Perinatal Mortality Survey (ZMPMS) study sites

Supplementary Files

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